PCT/GB03/04032

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NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

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Date of mailing (day/month/year) 11 November 2003 (11.11.03)	
Applicant's or agent's file reference RA/P302551WO	**IMPORTANT NOTIFICATION**
International application No. PCT/GB03/04032	International filing date (day/month/year) 19 September 2003 (19.09.03)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 21 September 2002 (21.09.02)
Applicant KH TECHNOLOGY CORPORATION et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

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Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
21 Sept 2002 (21.09.02)	0221995.4	GB	06 Nove 2003 (06.11.03)

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. (41-22) 338.87.40	Authorized officer Maurice COVINO Telephone No. (41-22) 338 8455

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22SEP02 E750146-1 000335
P01/7700 0.00-0221995.4

1.	Your reference	RBT/P301805GB
2.	Patent application number *(The Patent Office will fill in*	0221995.4
3.	Full name, address and postcode of the or of each applicant (*underline all surnames*)	KH Technology Corporation Floor 2, Zephyr House Mary Street George Town Grand Cayman Cayman Islands British West Indies 21 SEP 2003
	Patents ADP number (*if you know it*)	808 683001
	If the applicant is a corporate body, give the country/state of its incorporation	British West Indies
4.	Title of the invention	IMPROVEMENTS IN ELECTROMECHANICAL TRANSDUCERS
5.	Name of your agent (*if you have one*)	**W. P. Thompson & Co.**
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	Eastcheap House, Central Approach Letchworth Herts SG6 3DS
	Patents ADP number *(if you know it)*	158003
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country / Priority application number *(if you know it)* / Date of filing *(Day/month/year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application / Date of filing *(Day/month/year)*
8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *See note (d))*	Yes

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Continuation sheets of this form	
Description	8
Claims	
Abstract	
Drawing(s)	3

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(Please specify)*	

11. We request the grant of a patent on the basis of this application

Signature

W. P. Thompson & Co.

Date September 20, 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

Roger Thomson
01462 682139

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IMPROVEMENTS IN ELECTROMECHANICAL TRANSDUCERS

This invention relates generally to electromechanical transducers, and is particularly concerned with electrodynamic loudspeakers.

Electrodynamic loudspeakers typically use permanent magnets within a magnetic circuit of ferromagnetic material to create magnetic flux in an air gap within which a voice coil is displaceable. The magnetic circuit directs the flux produced by the permanent magnet into the air gap. When no current flows through the voice coil, the magnetic flux in the air gap is constant. The voice coil receives signals which produce a current in the coil in a direction which is substantially perpendicular to the direction of the lines of magnetic flux produced by the permanent magnet. The coil is connected mechanically to a diaphragm which is driven by the axial motion of the coil produced by the motor force on the coil.

Various types of distortion can arise in the translation of a given electrical signal from an amplifier into the sound heard by a listener. A particular problem arises in relation to second harmonic and third harmonic distortion.

A further factor which is relevant to the design of loudspeakers is the length of the voice coil or voice coils in relation to the length of the air gap within which the coil or coils move. In most loudspeaker designs the length of the coil is more than the length of the air gap and the axial motion of the coil is substantially dependent on the length of the coil, so that the voice coil does not move

beyond the region in which the flux density is substantially constant and perpendicular to the coil. In the case of a short or "underhung" coil magnetic modulation distortion can occur which affects the linearity of response of the loudspeaker. The magnetic field which is generated by the voice coil modulates the field in the air gap which interacts with the current voice coil to generate the driving force. In the air gap there are two magnetic fields, one generated by the voice coil and one generated by the permanent magnet. These fields are not superimposed but are added to each other. This causes distortion, particularly second harmonic and third harmonic distortion, because the driving force will vary depending upon the incoming signal to the voice coil. This is particularly so at low frequencies.

Attempts have been made to solve these problems by using a short voice coil within a long air gap. However, although this is a customary design, it has only limited effectiveness.

It is also known to try to overcome this problem by creating eddy currents in the magnetic circuit to produce a magnetic field which opposes the magnetic field generated by the voice coil. This can help to reduce the variations in magnetic flux to some extent.

It is also known to stabilise the magnetic flux profile by setting conductive rings into the pole piece. With the correct length of coil this does give some improvement in reducing distortion. However, because the flux through the voice coil and the flux within the magnetic circuit is not ideal, and because of the resistance and skin effects of the

conductive rings, which limits the current, these flux stabilization measures become ineffective at low frequencies.

International patent application WO91/05447 describes an electrodynamic speaker in which a shorted turn is positioned in the air gap to reduce the inductance that the loudspeaker presents as a load to a driving source and to increase the fidelity of reproduction of an input signal.

International patent application WO/89/02501 describes a magnetic circuit for an electromechanical transducer, such as a loudspeaker, in which compensating coils or compensating conductors are provided within grooves formed in the surface of the pole pieces of the magnetic circuit. These compensating coils or conductors are supplied with a current corresponding to the signal current, in order to produce an opposing magnetic field to that produced by the voice coil.

None of these known designs and structures is able significantly to reduce second harmonic and third harmonic distortion at low frequencies.

It is an object of the present invention to provide an electromechanical transducer, particularly an electrodynamic loudspeaker, in which second harmonic and third harmonic distortion is significantly reduced, especially at low to mid-range frequencies, i.e. up to about 150 Hz.

It is a further object of the present invention to provide a loudspeaker driver which has exceptionally high linearity.

The present invention is based upon the recognition that the path of the magnetic flux from the voice coil through the pole pieces is not the same as the path of the magnetic flux

from the permanent magnet through the pole pieces. Consequently, in accordance with the invention, the permeability of the path of the magnetic flux from the voice coil is decreased, by decreasing the permeability of the magnetic circuit. This decrease in the permeability of the magnetic circuit is achieved by splitting or dividing the magnetic circuit to make it a multi-pole circuit. This is achieved by introducing at least one separation into the magnetic circuit, thereby to create at least two, and preferably three or more poles.

This division of the magnetic circuit can be accomplished by the use of air gaps and/or rings of conductive or non-conductive material within the magnetic circuit. In this way one can create two or more poles, thus decreasing the permeability of the magnetic circuit and enabling the achievement of an ultra-linear driver.

The present invention is not limited to the use of a single voice coil within the air gap of the loudspeaker. The invention is also appropriate to embodiments which use two voice coils within the air gap.

A further advantage of the present invention is that the choice of coil length and gap length is less critical. One can even use a long coil within a short gap, although there will be some flux modulations with such a configuration.

In order that the invention may be more fully understood, a number of embodiments in accordance with the invention will now be described by way of example and with reference to the accompanying drawings. In the drawings:

Fig. 1 is a schematic diagram showing a first embodiment

of magnetic circuit for a loudspeaker in accordance with the invention;

Fig. 2 is a schematic diagram of a second embodiment of magnetic circuit for a loudspeaker in accordance with the invention; and

Fig. 3 is a schematic diagram of a third embodiment of magnetic circuit for a loudspeaker in accordance with the invention, here using two voice coils.

Referring first to Fig. 1, there is shown the magnetic circuit of a loudspeaker, the other parts of which are not shown. The assembly comprises a single voice coil 10 which is carried by a former 12 and is positioned within an air gap 14. Two permanent magnets 16a and 16b are positioned adjacent to the air gap 14, one above the voice coil and one below the voice coil. These permanent magnets 16a, 16b can be of a neodymium alloy material for example. The magnetic circuit comprises a plurality of elements of ferromagnetic material, such as mild steel. In this embodiment there are four such elements, which constitute separate pole pieces. These pole pieces are indicated at A, B, C and D. Pole piece A encompasses the permanent magnets and the air gap, while pole pieces B, C and D are positioned to one side of the air gap between the permanent magnets 16a and 16b. One thus has a multi-pole piece structure.

The assembly also includes a plurality of rings of conductive material, for example of aluminium or copper. Alternatively, rings of a non-conductive material could be used in some circumstances. Two rings 18a and 18b are positioned on the inside of the air gap 14 and separate the

pole piece elements B, C and D from one another. On the outside of the air gap, directly opposite the rings 18a and 18b are conductive rings 20a and 20b. Adjacent to the bottom of the former 12 are positioned further conductive rings 22 and 24, one on the inside of the former and the other on the outside of the air gap. Adjacent to the top of the former 12 are positioned further conductive rings 26 and 28, the former on the inside of the former 12 and the latter on the outside of the former, in contact with the upper portion of the pole piece element A. An air gap 30 is left between the pole piece elements A and C, and the air gap 14 is enlarged at the bottom of the former around conductive ring 22.

Referring now to Fig. 2, in which the same or equivalent parts as in Fig. 1 are indicated by the respective same reference numerals, this shows an alternative embodiment, again using air gaps and conductive rings to separate the pole piece elements A, B, C and D from one another. In this embodiment, the air gap 30 of Fig. 1 is filled by a further ring 32 of conductive material, such as aluminium or copper. Also, the rings 18a and 18b of conductive material in Fig. 1 are here replaced by smaller rings 34a and 34b of conductive material and air gaps 36a and 36b. On the outside of the voice coil the conductive rings 20a and 20b of Fig. 1 are omitted, leaving air gap recesses 38a and 38b opposite the conductive rings 34a and 34b. The other elements of the assembly are unchanged.

Fig. 3 shows an alternative embodiment which comprises two voice coils 40a and 40b, a single permanent magnet 42 and four pole piece plates on each side of the air gap within

which the voice coils move. The permanent magnet 42 can again be of neodymium alloy material and the individual plates of mild steel or other ferromagnetic material. In this embodiment the individual plates 44a, 44b, 44c and 44d on the magnet side of the voice coils and the pole piece plates 46a, 46b, 46c and 46d on the outside of the voice coils are each separated by respective air gaps, without the use of conductive rings as in Figs. 1 and 2.

It has been shown that substantial reductions in second harmonic and third harmonic distortion can be achieved with the embodiments of the magnetic circuit shown in Figs. 1 to 3. Taking the embodiment of Fig. 3 as an example, whereas with a conventional magnetic circuit one might achieve a reduction in the second harmonic distortion of -19db, with an accompanying increase in the third harmonic distortion of +3db, with the motor drive of Fig. 3 one can achieve a reduction in the second harmonic distortion of approximately -32db, with a reduction also in the third harmonic distortion of about -5db. One thus has a highly linear motor.

Although in each of the embodiments described above the pole piece assembly comprises four pole piece elements, it is to be understood that the invention covers also the use of two poles, three poles or more than four poles, with or without rings of conductive or non-conductive material. It is only necessary that the three or more poles should be separated or divided in such a way that they are not in direct physical contact one with another and that the magnetic path between the poles should have minimum reluctance.

Although the embodiments described above show magnetic structures which are arranged to provide cylindrical symmetry with respect to an annular air gap, with the symmetry being about the longitudinal axis of the loudspeaker, the invention is also applicable to the use of magnetic circuits which are not axially symmetrical in terms of the magnet geometry. A non-axisymmetric version has higher reluctance between the plates.

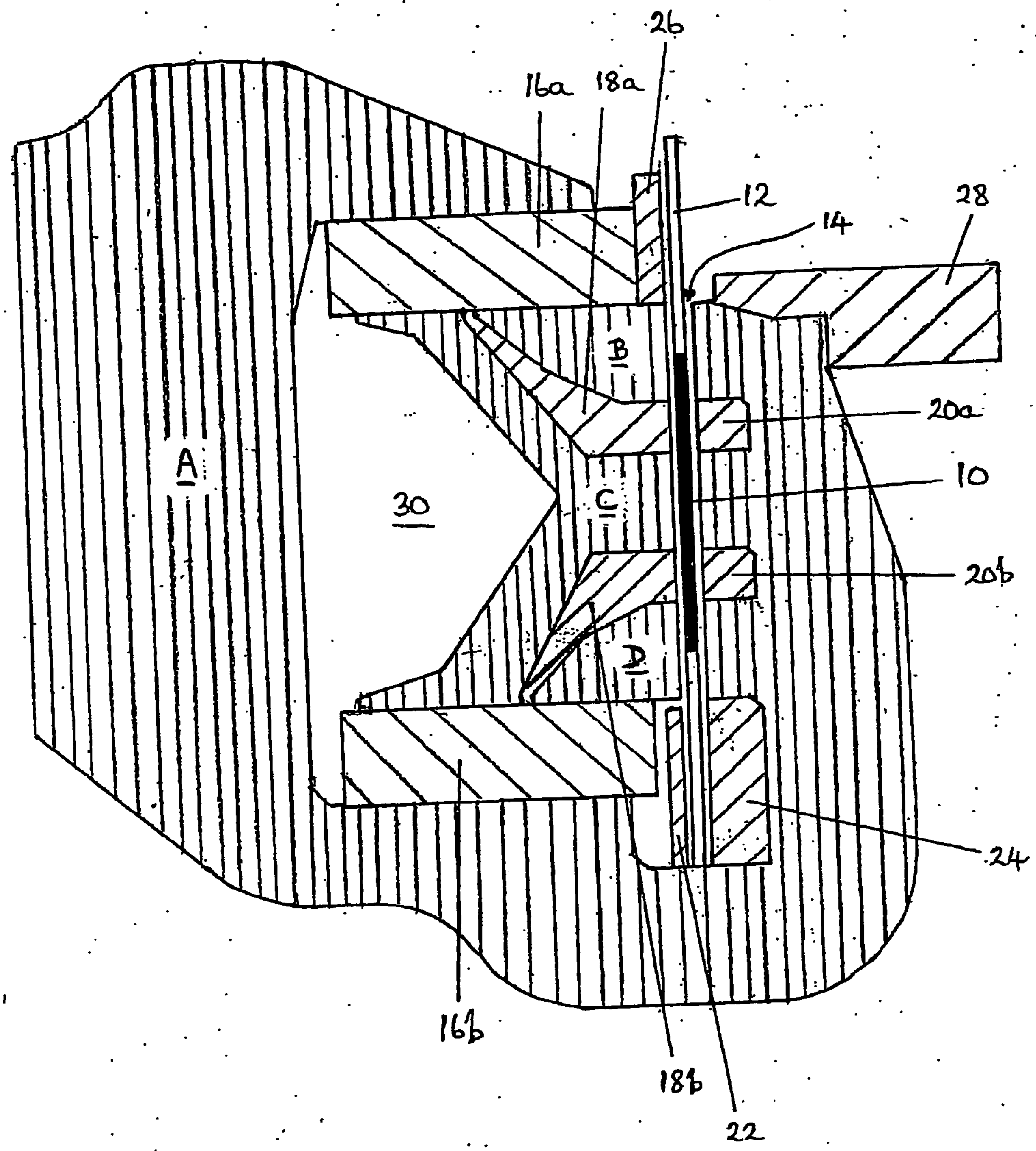

Fig.1.

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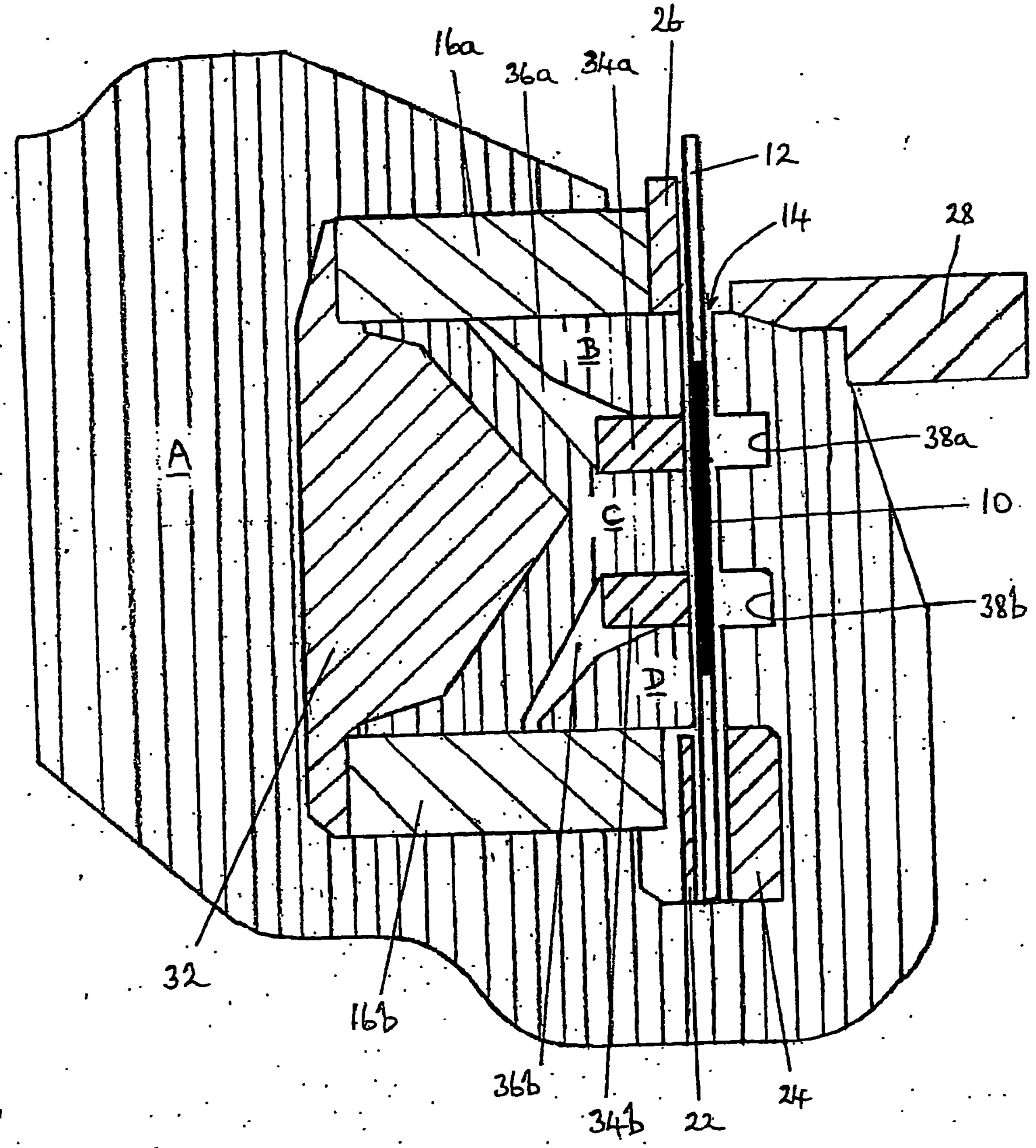

Fig. 2.

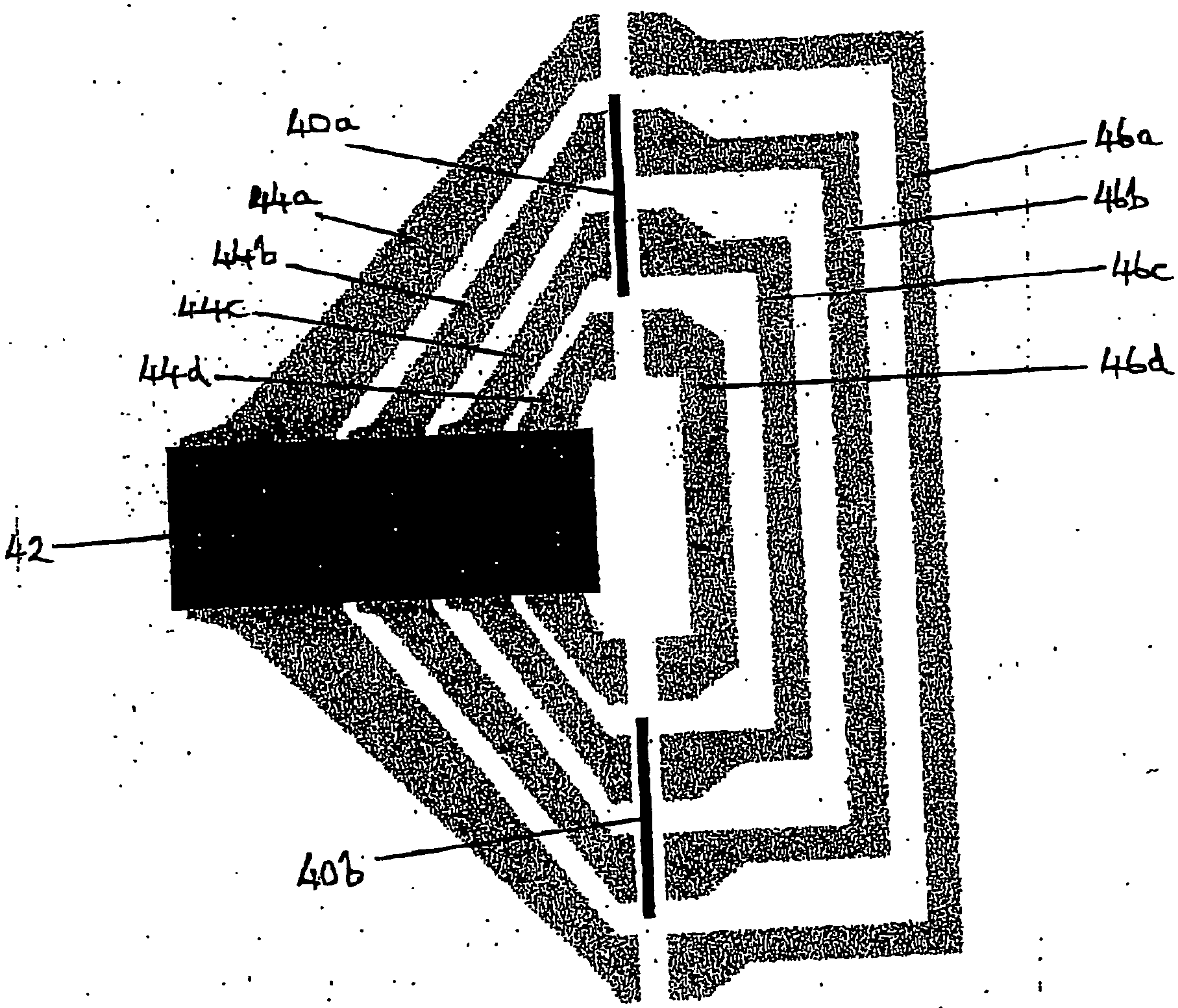

Fig.3